## DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the glass substrate which uses the processing method of amorphous materials and these amorphous materials, such as inorganic glass material.

[0002]

[Description of the Prior Art]It has high hardness and homogeneous physical properties, the glass as amorphous materials is cheap, and since it excels in economical efficiency, it is used in the various fields from the former.

[0003]That is, the glass substrate in which the minute projection was formed in the surface can manufacture the liquid crystal display element which has a desired cell gap in a liquid crystal display element, without said projection playing the role which determines the so-called gap length of a cell gap, and using the glass bead for cell gap adjustment.

[0004]Also when manufacturing the optical diffraction grating which has the projection which the glass substrate in which this kind of a minute projection and minute unevenness were formed in the surface played the optical disc, the magneto-optical disc, or the role with said minute unevenness important for signal reading, and was arranged regularly, the glass substrate serves as important parts.

[0005]And this kind of glass substrate is widely used also for the substrate for magnetic disks of a hard disk drive (HDD).

[0006]By the way, in HDD, generally, while the disk is standing it still, a magnetic head contacts a disk surface, Starting of HDD adopts the drive system called the CSS (Contact Start Stop) method to which the high velocity revolution of the disk is carried out where a magnetic head is slightly floated from a disk.

[0007]And when making HDD drive with CSS, and floating a magnetic head from the starting

time, in order for a magnetic head to adhere to a disk or to reduce friction at the time of starting and a stop, generally forming the fine irregularities called a texture on the surface of a glass substrate is performed. That is, although glass is a brittle material and shape working is remarkably difficult for it compared with a plastic material, the various methods of forming fine irregularities on the surface of a glass substrate are developed and put in practical use from before from the usefulness as a disc substrate.

[0008]For example, an etching process is performed to JP,64-42025,A using the drug solution containing fluoride or hydrogen fluoride gas, and the art which formed fine irregularities on the glass substrate by this is indicated (the 1st conventional technology).

[0009]After carrying out crystallization treatment of the glass substrate to JP,7-296380,A and carrying out mirror polishing of the surface to it, it processes with the etching reagent which added sulfuric acid or ammonium fluoride to fluoric acid, and the art in which detailed unevenness was formed on the glass substrate surface is indicated (the 2nd conventional technology).

[0010]After applying to a substrate where an ultrafine particle is mono-dispersion-ized, and etching a surface protection layer into JP,8-249654,A by dry etching subsequently, the art which removed the ultrafine particle and formed detailed unevenness on the surface of the substrate is indicated (the 3rd conventional technology).

[0011]JP,7-182655,A and JP,9-194229,A are irradiated with the laser of predetermined energy on the surface of a glass substrate, a laser radiation part is upheaved to them, and the art which formed the height on the surface of the glass substrate by this is indicated (the 4th conventional technology).

[0012]

[Problem(s) to be Solved by the Invention]However, since it is only performing the etching process using the drug solution which contains fluoride in the 1st conventional technology of the above to the glass which has predetermined chemical composition, or hydrogen fluoride gas, The surface unevenness formed became a split face where projected height is also irregular, and there was a problem that it was difficult to obtain the texture which has uniform projected height.

[0013]The 2nd conventional technology of the above carries out crystallization treatment of the glass substrate, and forms a crystallization layer and an amorphous layer, Surface unevenness was formed on the glass substrate using a crystal layer differing in an etch rate from an amorphous layer, therefore there was a problem of being inapplicable in the usual homogeneous glass material.

[0014]By the 3rd conventional technology of the above, after laminating an ultrafine particle on a substrate and performing dry etching, since the ultrafine particle is removed, unlike the case where mask with the usual metallic mask and an etching process is performed, it is thought

possible to form minute surface unevenness, but. The etch rate of dry etching was slow, for this reason, jump-ization of cost was caused, and there was a problem of being unsuitable in mass production.

[0015]Since the 4th conventional technology of the above was irradiating with laser on the surface of a glass substrate, there was a problem that a processing object was limited to the glass material which has a big absorbancy index to the laser beam of a specified wavelength. In this 4th conventional technology, since the projected height of the heights formed was very sensitive to the output of a laser beam, there was a problem that it was difficult to obtain the uniform heights which have desired projected height.

[0016]Thus, in the 1st thru/or the 4th conventional technology, there were the fine irregularities and the problem that minute heights in particular cannot be mass-produced industrially had still uniform projected height. And in the field of HDD, much more densification of a disk is demanded, and projected height of the surface unevenness of a glass substrate is made low as much as possible in connection with the densification of a disk, and the homogeneity of this projected height has been required in recent years.

[0017]This invention was made in view of such a situation, and is ****. The purpose is to provide the substrate for magnetic disks which uses the processing method of amorphous materials and these amorphous materials which can form in the desired position of amorphous materials the surface heights which have projected height.

[0018]

[Means for Solving the Problem]That this invention persons should form in a desired position of amorphous materials minute heights which have uniform projected height, As a result of inquiring wholeheartedly, amorphous materials, such as inorganic glass, acquired knowledge of having chemical property which starts plastic flow, carries out densification and is different in a compression layer by which densification was carried out, and incompressible layers other than this compression layer, by pressurizing by high pressure force also in ordinary temperature.

[0019]And when this invention person etc. advanced research further, knowledge that said compression layer was processible into a convex configuration was acquired by performing a solvent wiping removal of a surface layer of said amorphous materials using a treating solution in which removal ability differs in said compression layer and incompressible layers other than this compression layer.

[0020]A processing method of amorphous materials where this invention is made based on these knowledge and which are applied to this invention, A compression layer by which densification was carried out by carrying out load of the predetermined welding pressure selectively to the surface of amorphous materials is formed, Subsequently, a surface layer of

said amorphous materials is removed using a processing agent from which removal ability differs in this compression layer and incompressible layers other than this compression layer, It is characterized by processing said compression layer into a convex configuration, and is characterized by said amorphous materials being specifically inorganic glass, and said processing agent is further characterized by being an etching reagent in which said compression layer differs in an etch rate from said incompressible layer.

[0021]It is preferred to use an acidic solution containing acid which can present a big etching operation to inorganic glass, especially acidic etchant containing fluoric acid as an etching reagent.

[0022]By the way, if an etching process is performed by acidic etchant, a part of ingredient which constitutes inorganic glass will be eluted to acidic etchant, and a deterioration layer will be formed in the surface of an incompressible layer. And it became clear that this deterioration layer is removable by performing an etching process with an alkaline etching reagent by this invention person's etc. research result.

[0023]Then, after a processing method of amorphous materials of this invention performs the 1st etching process by said acidic etchant, it is characterized by performing the 2nd etching process with an alkaline etching reagent.

[0024]Thus, since said deterioration layer is removable by performing the 2nd etching process with an alkaline etching reagent after performing the 1st etching process, Since it can be kept homogeneous a glass surface and inside glass and projected height of surface heights becomes high, amorphous materials which carried out suitable to a use for which high projected height is needed can be obtained.

[0025]Although inorganic glass which is amorphous materials uses a silicon oxide as the main ingredients, since an aluminum oxide is easily eluted to an acidic solution when an aluminum oxide contains in this inorganic glass, an etching process is promoted by acidic etchant. And an aluminum oxide is excellent in corrosion resistance to medicine other than acid. Therefore, as for a compression layer by which densification was carried out, while an elaborated silicon oxide bars elution of other ingredients, in an incompressible layer, an aluminum oxide is selectively etched by acidic etchant and, as a result, minute heights are easily formed in the inorganic glass surface.

[0026]Therefore, it is preferred that said amorphous materials contain a silicon oxide and an aluminum oxide at least.

[0027]An alkali earth metal oxide is easily eluted to an alkaline solution containing a chelating agent, and is excellent in a water resisting property. Therefore, when an alkali earth metal oxide is contained in amorphous materials, An alkali earth metal oxide is selectively etched with an alkaline etching reagent containing a chelating agent, and it becomes possible [ the etching process by an alkaline etching reagent ] to form minute heights in a glass surface.

[0028]Then, this invention is characterized by said etching reagent being an alkaline solution containing a chelating agent, and said amorphous materials, It is also preferred that it is characterized by containing at least a silicon oxide and at least one or more sorts of oxides chosen from a group which comprises an alkali earth metal oxide.
[0029]In order to form a compression layer on the surface of amorphous materials, it is necessary to press said amorphous materials by a member which has bigger hardness than hardness of amorphous materials.
[0030]Then, this invention carries out relative displacement of said surface top, where it was characterized by said compression layer pressing and forming an indenter which has bigger hardness than hardness of said amorphous materials or said indenter is pressed on the surface of amorphous materials, and it is characterized by forming said compression layer.
[0031]In order to form said compression layer on the surface of amorphous materials, detailed processing can be performed if said indenter is used for a probe.
[0032]In particular, detailed processing can be ensured when said probe is a probe of scanning probe microscopy.
[0033]It is also preferred to make particles which have bigger hardness than hardness of amorphous materials as a method of forming other surface heights collide with the surface of said amorphous materials, and to form a lot of surface heights at once.
[0034]Said particle is characterized by being slurry form from a viewpoint of avoiding a surface damage of amorphous materials.
[0035]Since a compression layer presses an indenter and is formed, a hollowed part corresponding to bottom shape of an indenter is usually formed in the parietal region of a compression layer. Therefore, after forming a compression layer, before performing a solvent wiping removal of a surface layer, a surface treatment is performed if needed and it may be made to remove a hollowed part.
[0036]That is, after forming said compression layer, it is also preferred to perform a surface treatment to this compression layer, and to remove said surface layer after that using said processing agent.
[0037]As for said surface treatment, it is preferred to grind with a loose grain which has hardness of said amorphous materials and the hardness below equivalent from a viewpoint of avoiding a surface damage of amorphous materials, for example, colloidal silica.
[0038]Amorphous materials comprise multicomponent system inorganic glass, and a glass substrate concerning this invention is characterized by forming heights by a processing method of the above-mentioned amorphous materials.
[0039]Amorphous materials obtained by the above-mentioned processing method are arbitrary a large number and patterns about heights whose projected height is it is high and uniform and detailed, For example, since it is possible for you to make it distributed over concentric circle

shape, a glass substrate is used for a substrate for magnetic disks, A magnetic head can be prevented from adhering to a substrate at the time of starting even when it drives with CSS, Furthermore a read error by gap change with a magnetic head and a substrate under run or collision with a magnetic head and a substrate can be prevented, and a magnetic disk board excellent in noise figure can be obtained.

[0040]

[Embodiment of the Invention]Next, an embodiment of the invention is explained in full detail based on a drawing.

[0041]Drawing 1 is an explanatory view of a manufacturing process showing the 1 embodiment (a 1st embodiment) of the processing method of the amorphous materials concerning this invention.

[0042]In drawing 1 (a), 1 is the inorganic glass 1 as amorphous materials, and in this embodiment. The characteristic at the time of using it as the etching nature to an acidic solution and an alkaline solution or a substrate for magnetic disks is taken into consideration, The composition range $SiO_2$:55-mol% - 72-mol%, aluminum$_2O_3$:1 mol 12.5 mol [ % - ] %, an alkali earth metal oxide (MgO, CaO, SrO, and BaO): Less than $Na_2O$:12mol% is used with the total O:5 mol of 2-mol% and Li $_2$% - 20-mol%. [ % - 16 mol]

[0043]Hereafter, the reason for limitation is explained.

[0044]$SiO_2$ is a basic component which constitutes inorganic glass, if content will be less than [ 55mol% ], while the endurance of glass will get worse, if 72-mol% is exceeded, viscosity will go up too much and melting will become difficult. So, in this embodiment, the content of $SiO_2$ was set up to 55-mol% - 72-mol%.

[0045]aluminum$_2O_3$ is an ingredient which raises the endurance of glass, and is an ingredient easily eluted to acidic etchant. However, if the content cannot do an expected operation effect so less than [ 1mol% ] but the content exceeds 12.5-mol% on the other hand, viscosity will go up too much, devitrification-proof nature will fall, and melting will become difficult. So, in this embodiment, the content of aluminum$_2O_3$ was set up to 1-mol% - 12.5-mol%.

[0046]Although MgO, CaO, SrO, BaO, etc. are alkali earth metal oxides, This alkali earth metal oxide improves the melting nature of inorganic glass, and also is easily eluted to the alkaline solution containing a chelating agent, therefore promotes an etching process to this alkaline etching reagent. However, the content cannot do an expected operation effect so at less than 2mol%, but on the other hand, if the content exceeds 16-mol%, the liquid phase temperature of glass will rise and devitrification-proof nature will get worse. So, in this embodiment, the content of MgO, CaO and SrO which are alkali earth metal oxides, and BaO was set up to 2-mol% - 16-mol% with the total.

[0047]When the content is less than [ 5mol% ], viscosity goes up, melting becomes difficult, and although $Li_2O$ is an ingredient which improves the melting nature at the time of glass melting, if the content exceeds 20-mol%, on the other hand, chemical durability will get worse. So, in this embodiment, the content of $Li_2O$ was set up to 5-mol% - 20-mol%.

[0048]Although $Na_2O$ is also an ingredient which improves the melting nature at the time of glass melting, if the content exceeds 12-mol%, chemical durability will get worse. For this reason, in this embodiment, the content of $Na_2O$ was set to less than 12mol%.

[0049]Chemical strengthening by ionic exchange becomes possible by making alkali metal oxides, such as these $Li_2O$ and $Na_2O$, contain in the inorganic glass 1.

[0050]The above-mentioned inorganic glass 1 can make colorant, such as $Fe_2O_3$, MnO, NiO, $Cr_2O_3$, and CoO, etc. contain suitably in the range which does not spoil the various characteristics which this invention is demanding.

[0051]Besides the inorganic glass 1 which has the presentation as above substrates for magnetic disks, For example, this invention is effective also to the inorganic glass which adds to aluminum$_2O_3$ and contains $B_2O_3$, and the inorganic glass which has an ingredient for controlling a refractive index for alkali free glass and optical applications.

[0052]Subsequently, as shown in the arrow A of drawing 1 (a), the indenter 2 is pressed against the surface of the inorganic glass 1, and as shown in drawing 1 (b), the compression layer 4 which has the hollowed part 3 is formed in the surface of the inorganic glass 1. Repeat execution of this processing is carried out, and the compression layer 4 is formed in each of the position of two or more requests.

[0053]The indenter 2 needs to have bigger hardness than the hardness of the inorganic glass 1, and can use the material of the product made from a diamond, or the product made from cemented carbide. moreover -- as the shape of the indenter 2 -- a gimlet -- type shape is preferred, although the shape where pyramid shape etc. are arbitrary can be used according to desired projection shape as bottom shape of a gimlet form, from a viewpoint of preventing generating of a crack, distribution of compressive force, such as a surface of a sphere, is uniform, and the shape which does not have a ridgeline is preferred.

[0054]A probe can be used as the indenter 2. As said probe, the probe for scanning probe microscopy (SPM) can also be used, for example. By using SPM, it is possible to form the pattern of the compression layer 4 in the minute field of mum order with controllability sufficient in arbitrary positions. The compression layer 4 can be formed in not only punctiform but a line, or surface state by sweeping the surface of the inorganic glass 1 with a probe at this time. In particular the construction material or shape of the probe which can be used are not limited.

[0055]In the case of the indenter 2 made from a diamond, the welding pressure at the time of

pressing the indenter 2 against the inorganic glass 1 is set as load 0.3GPa - 4GPa by this embodiment. That is, when load is less than 0.3 GPa, the compression layer 4 cannot be formed in the surface of the inorganic glass 1, but on the other hand, when load exceeds 4GPa, there is a possibility that destruction of a crack etc. may arise. So, in this embodiment, the load in which load is carried out to the inorganic glass 1 by the indenter 2 was set as 0.3GPa - 4GPa in general.

[0056]Next, as the inorganic glass 1 with which the compression layer 4 was formed is immersed in acidic etchant, the 1st etching process is performed, the surface layer of the inorganic glass 1 is removed and this shows drawing 1 (c), The minute heights 5 are formed in compression layer 4 portion, further, from incompressible layers 6 other than compression layer 4, ingredients other than $SiO_2$ are eluted and the deterioration layer 7 is formed.

[0057]That is, an ingredient with strong acid resistance and an ingredient with weak acid resistance are during the presentation of the inorganic glass 1. Specifically, $SiO_2$ has the special feature that acid resistance is strong and aluminum$_2O_3$, an alkali metal oxide ($Li_2O$ and $Na_2O$), and alkali earth metal oxides (MgO, CaO, SrO, BaO, etc.) tend to be eroded by acid.

[0058]Therefore, since elaborated $SiO_2$ bars [ elution of other ingredients ] the compression layer 4 by which densification was carried out, while it cannot be easily etched by acidic etchant, the incompressible layer 6 etches ingredients other than a $SiO_2$ ingredient selectively by acidic etchant. And thereby, in the incompressible layer 6, etching is promoted, and the compression layer 4 serves as the minute heights 5, and remains.

[0059]As mentioned above, as for the incompressible layer 6, acidic etchant etches ingredients other than a $SiO_2$ ingredient selectively, but [ as a result ] ingredients other than $SiO_2$ are eluted and the porosity deterioration layer 7 is formed in the surface of the incompressible layer 6.

[0060]Although solution, such as sulfuric acid, nitric acid, chloride, and fluoroacetic acid, can be used as acidic etchant, In order to perform a desired etching process promptly, it is desirable that it is solution of strong acid, especially concentration is excellent in an etching operation, and the solution containing fluoric acid beyond 0.005vol% has it. [ most preferred ]

[0061]Subsequently, it is immersed in an alkaline etching reagent and the 2nd etching process is performed, and as shown in drawing 1 (d), the deterioration layer 7 is removed. That is, since the deterioration layer 7 is an unstable porous part chemically and is the portion into which ingredients other than $SiO_2$ were eluted from the surface of the inorganic glass 1, it makes a glass surface a chemically stable structure like the inside of glass by removing this deterioration layer 7.

[0062]As an alkaline etching reagent, the diluent of pH 11 or more potassium hydroxide

solutions and a commercial alkaline cleaning solution can be used, for example.
[0063]As for an alkali earth metal oxide, it is also preferred that the alkaline etching reagent which was easily eluted to the alkaline solution containing a chelating agent, and contained the chelating agent from this viewpoint performs the 2nd etching process.
[0064]Here, as a chelating agent, phosphates, such as polyvalent carboxylic acid, such as aminocarboxylic acid, such as EDTA (ethylenediaminetetraacetic acid) and NTA (nitrilotriacetic acid), and oxalic acid, and STPP (sodium tripolyphosphate), can be used.
[0065]Thus, since the minute heights 5 are formed in the portion which formed the compression layer 4 and formed the compression layer 4 in the compression layer 4 and the incompressible layer 6 using the difference of etching nature according to a 1st embodiment, the minute heights 5 with uniform projected height can be formed in the inorganic glass 1 surface by arbitrary patterns.
[0066]Drawing 2 is an explanatory view of a manufacturing process showing a 2nd embodiment of this invention, in a 2nd embodiment, as shown in drawing 2 (a), the spherical indenter 8 is pressed against the surface of the inorganic glass 1, subsequently to the direction of arrow B it sweeps, and the linear compression layer 9 is formed along with the moving track of the indenter 8. Repeat execution of this processing is carried out, and the compression layer 9 is formed in each of the position of two or more requests.
[0067]subsequently, a 1st embodiment -- the same -- acidic etchant -- it is preferably immersed in fluoric acid solution, the 1st etching process is performed, a surface layer is removed, and thereby, as shown in drawing 2 (b), the linear minute heights 10 and the deterioration layer 11 are formed.
[0068]Subsequently, an alkaline etching reagent removes the deterioration layer 11, and as shown in drawing 2 (c), the inorganic glass 1 with which the linear minute heights 10 were formed is manufactured.
[0069]Thus, by sweeping the indenter 8 and forming the compression layer 9 as well as a 1st embodiment, the minute heights 10 with uniform projected height can be formed in the inorganic glass 1 surface by arbitrary patterns.
[0070]The particles which have larger hardness than the inorganic glass 1, for example can be made to be able to collide with the surface of the inorganic glass 1 as other methods of forming the compression layer 4, and many compression layers 4 can be formed in the surface of the inorganic glass 1 at once. Wet blasting etc. which spray the particles made into slurry form as a method of making particles colliding, through fluids which spray particles on the inorganic glass 1 through air, such as the air-blast method and water, for example on the inorganic glass 1 are mentioned. Since it can be made to collide with the surface of the inorganic glass 1, without making each particle condense since especially the latter is carrying out through the fluid and is easy to control injection speed, Since it is possible for there to be almost no

generating of the crack by overpressure or a crack, and to form the compression layer 4 in the surface of the inorganic glass 1 uniformly, it is more desirable as a formation method of the compression layer 4.

[0071]When forming the compression layer 4 and an etching process is carried out in the state where this hollowed part 3 was made to remain since the hollowed part 3 is formed as shown in drawing 1 (b), the shape of the minute heights 5 may turn into the shape of an abbreviated V character, or the shape of a caldera, as shown in drawing 1 (d). Therefore, after performing a surface treatment depending on the use of the inorganic glass 1 and removing the hollowed part 3, it may be made to perform an etching process.

[0072]It is necessary to make it a crack etc. not attached to the inorganic glass 1 as a surface treatment here. Therefore, it is preferred to carry out grinding treatment using the loose grain which is equivalent to the hardness of the inorganic glass 1, or has the hardness not more than it, as for a loose grain, it is preferred that it is a globular form, for example, colloidal silica can be used.

[0073]Since alkaline-earth metals are easily eluted to the alkaline solution containing a chelating agent as mentioned above, The compound containing alkaline-earth metals, i.e., MgO, CaO, SrO, BaO, etc. are selectively etched to said alkaline etching reagent, Therefore, when projected height may be small, it is also possible to omit the etching possibility by an alkaline solution of, i.e., etching which uses an acid etching solution.

[0074]When using the above-mentioned amorphous materials as a substrate for magnetic disks, it is preferred after the 2nd etching process by an alkaline etching reagent to perform chemical strengthening treatment and to heighten the surface pressure shrinkage stress of a glass substrate. Namely, it is immersed in the fused salt of potassium nitrate and sodium nitrate which were prepared by the predetermined capacity factor, for example under the temperature of 360 ** - 380 ** for 0.5 hour - 4 hours, It can prevent damaging, even if ionic exchange of the alkaline ion in inorganic glass is carried out to the alkaline ion which has a bigger ion radius, surface pressure shrinkage stress is heightened and it carries out the high velocity revolution of the magnetic disk by this.

[0075]And the amorphous materials obtained by the above-mentioned processing method, Since it is possible to be arbitrary a large number and patterns, and to distribute over concentric circle shape the heights whose projected height is uniform and detailed, for example, A magnetic head can be prevented from adhering to a substrate at the time of starting, even when the above-mentioned amorphous materials are used as a substrate for magnetic disks, and it drives with CSS, Furthermore the read error by gap change with the magnetic head and substrate under run or the collision with a magnetic head and a substrate can be prevented, and the magnetic disk board excellent in noise figure can be obtained.

[0076]

[Example]Next, the example of this invention is described concretely.

[0077]Table 1 was a presentation list of the inorganic glass 1 used by this example, and this invention persons used the inorganic glass 1 of the presentation 1 - the presentation 8 either [ which is shown in Table 1 ], produced the following specimens (Examples 1-13 and comparative examples 1 and 2), and observed the state (a bottom diameter and projected height) of surface heights.

[0078]

[Table 1]

| | $SiO_2$ | $B_2O_3$ | $Al_2O_3$ | MgO | CaO | BaO | $Li_2O$ | $Na_2O$ | $Fe_2O_3$ | $TiO_2$ | ZnO | $La_2O_3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 組成 1 | 64.8 | 0.0 | 10.0 | 2.9 | 4.2 | 0.0 | 7.4 | 10.6 | 0.1 | 0.0 | 0.0 | 0.0 |
| 組成 2 | 65.8 | 0.0 | 9.0 | 2.9 | 4.2 | 0.0 | 7.4 | 10.6 | 0.1 | 0.0 | 0.0 | 0.0 |
| 組成 3 | 71.6 | 0.0 | 0.9 | 6.0 | 8.4 | 0.0 | 0.0 | 13.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| 組成 4 | 64.3 | 0.0 | 10.0 | 2.9 | 4.2 | 0.0 | 7.1 | 10.6 | 0.9 | 0.0 | 0.0 | 0.0 |
| 組成 5 | 66.7 | 10.0 | 9.7 | 2.6 | 7.4 | 3.3 | 0.0 | 0.2 | 0.0 | 0.0 | 0.1 | 0.0 |
| 組成 6 | 62.2 | 16.0 | 8.2 | 0.1 | 0.1 | 13.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.0 | 0.0 |
| 組成 7 | 57.0 | 0.0 | 0.0 | 8.0 | 0.0 | 8.0 | 11.0 | 8.0 | 0.0 | 2.0 | 3.0 | 3.0 |
| 組成 8 | 57.0 | 0.0 | 1.2 | 7.4 | 0.0 | 7.4 | 11.0 | 8.0 | 0.0 | 2.0 | 3.0 | 3.0 |

単位はmol%

[0079][Example 1] After grinding in order to use the inorganic glass 1 of the presentation 1 and to raise the smooth nature of the surface of this inorganic glass 1, it held at the temperature of 460 ** for 2 hours, and distortion by polish was removed. Subsequently, the indenter 2 which consists of a diamond formed in the surface of the inorganic glass 1 at the pyramid shape of 136 degrees of vertical angles was pressed for 15 seconds by 5 g (3GPa) of load, and the compression layer 4 which has the 25 hollowed parts 3 by this was formed. And after this, 200 nm was ground using the slurry which colloidal silica as a loose grain mixed, and said hollowed part 3 was removed. Next, the inorganic glass 1 from which the hollowed part 3 was removed was immersed in concentration 0.025vol% of fluoric acid solution, and was etched, it was immersed in the alkaline etching reagent of pH12 after that, the deterioration layer 7 was removed, and the specimen of Example 1 was produced.

[0080]And when the shape of surface type of this specimen was observed by AFM (atomic force microscope), the minute heights 5 were formed on the surface of the specimen, and the bottom of the shape was the Yamagata shape of the one-side approximately square which is 4 micrometers. Projected height is 120nm**5nm and the uniform minute heights 5 with small variation in projected height were formed.

[0081][Example 2] After grinding in order to use the inorganic glass 1 of the presentation 1 and to raise the smooth nature of the surface of this inorganic glass 1, The indenter 2 which

consists of a diamond formed in the surface of the inorganic glass 1 at the pyramid shape of 136 degrees of vertical angles was pressed for 15 seconds by 10 g (1.5GPa) of load, and the compression layer 4 which has the hollowed part 3 by this was formed. Next, the inorganic glass 1 with which the compression layer 4 was formed was immersed in concentration 0.15vol% of fluoric acid solution, and was etched, it was immersed in the alkaline etching reagent of pH12 after that, the deterioration layer 7 was removed, and the specimen of Example 2 was produced.

[0082]And when the shape of surface type of this specimen was observed by AFM (atomic force microscope), the minute heights 5 were formed on the surface of the specimen, but. Unlike Example 1, since the surface treatment was not performed after compression layer 4 formation, the hollowed part 3 remained, and the shape was the caldera shape of the approximately square where the bottom was 8 micrometers per side. The concentration of fluoric acid solution was deeper than Example 1, for this reason, etching in the incompressible layer 6 was promoted, and, as a result, the projected height of the somma portion was 700 nm.

[0083][Example 3] After grinding in order to use the inorganic glass 1 of the presentation 1 and to raise the smooth nature of the surface of this inorganic glass 1, it held at the temperature of 460 ** for 2 hours, and distortion by polish was removed. Subsequently, the indenter 2 which consists of a diamond formed in the surface of the inorganic glass 1 at the pyramid shape of 136 degrees of vertical angles was pressed for 15 seconds by 1 g (0.6GPa) of load, and the compression layer 4 which has the hollowed part 3 by this was formed. And 100 nm was ground using the slurry which colloidal silica mixed after this, and said hollowed part 3 was removed. Next, the inorganic glass 1 from which the hollowed part 3 was removed was immersed in concentration 1vol% of sulfuric acid solution, and was etched, it was immersed in the alkaline etching reagent of pH12 after that, the deterioration layer 7 was removed, and the specimen of Example 3 was produced.

[0084]And when the shape of surface type of this specimen was observed by AFM (atomic force microscope), the minute heights 5 were formed on the surface of the specimen, and the bottom of the shape was the Yamagata shape of the one-side approximately square which is 4 micrometers. Since sulfuric acid solution was used as acidic etchant, compared with fluoric acid solution, the etching operation was small, and projected height was as low as 7 nm.

[0085][Example 4] After grinding in order to use the inorganic glass 1 of the presentation 2 and to raise the smooth nature of the surface of this inorganic glass 1, The tip pressed against the surface of the inorganic glass 1 the indenter 2 made from cemented carbide made into the spherical surface shape which is a curvature radius of 5 micrometers for 15 seconds by 1 g (0.6GPa) of load, and formed the compression layer 4 which has the hollowed part 3 by this. Next, this inorganic glass 1 was immersed in concentration 0.025vol% of fluoric acid solution,

and was etched, it was immersed in the alkaline etching reagent of pH12 after that, the deterioration layer 7 was removed, and the specimen of Example 4 was produced.

[0086]And when the shape of surface type of this specimen was observed by AFM (atomic force microscope), the minute heights 5 were formed on the surface of the specimen, and the shape turned into caldera shape used as the approximate circle form whose bottom is 6 micrometers in diameter. Compared with Example 1 (presentation 1), the content of aluminum$_2O_3$ was small, and, for this reason, etching in the incompressible layer 6 was not promoted, but the projected height of the somma portion was 25 nm.

[0087][Example 5] After grinding in order to use the inorganic glass 1 of the presentation 3 and to raise the smooth nature of the surface of this inorganic glass 1, it held at the temperature of 460 ** for 2 hours, and distortion by polish was removed. Subsequently, the indenter 2 which consists of a diamond formed in the surface of the inorganic glass 1 at the pyramid shape of 136 degrees of vertical angles was pressed for 15 seconds by 1 g (0.6GPa) of load, and the compression layer 4 which has the hollowed part 3 by this was formed. And 200 nm was ground using the slurry which colloidal silica mixed after this, and said hollowed part 3 was removed. Next, it immersed and etched into the alkaline etching reagent containing 1vol% of a potassium hydroxide solution, and 0.2vol% of EDTA, and the specimen of Example 5 was produced.

[0088]And when the shape of surface type of this specimen was observed by AFM (atomic force microscope), the minute heights 5 were formed on the surface of the specimen, and the bottom of the shape was the Yamagata shape of the one-side approximately square which is 4 micrometers. Since only the alkaline solution performed the etching process, without performing etching by an acidic solution, projected height was low compared with Example 1, and was 12 nm.

[0089][Example 6] After grinding in order to use the inorganic glass 1 of the presentation 1 and to raise the smooth nature of the surface of this inorganic glass 1, it held at the temperature of 460 ** for 2 hours, and distortion by polish was removed. Subsequently, the inorganic glass 1 top was swept for the roller made from cemented carbide the dihedral angle of 110 degrees, and 7 mm in diameter at 0.1 m/sec in 25 g of load, and speed, and the linear compression layer 4 was formed. And 300 nm was ground using the slurry which colloidal silica mixed after this, and the hollowed part 3 was removed. Next, the inorganic glass 1 from which the hollowed part 3 was removed was immersed in concentration 0.025vol% of fluoric acid solution, and was etched, it was immersed in the alkaline etching reagent of pH12 after that, the deterioration layer 11 was removed, and the specimen of Example 6 was produced.

[0090]And when the shape of surface type of this specimen was observed by AFM (atomic force microscope), on the surface of the specimen, the linear minute heights 10 with a flat crowning were formed, and the shape was 10 micrometers in width, and was 120 nm in

projected height.

[0091][Example 7] After grinding in order to use the inorganic glass 1 of the presentation 1 and to raise the smooth nature of the surface of this inorganic glass 1, The zirconia particle with a particle diameter of 20 micrometers was sprayed for 20 seconds using the compressed air of $9.8x10^4$Pa (1 kg/cm$^2$), and the compression layer 4 of a large number which have the hollowed part 3 by this was formed. And 200 nm was ground using the slurry which colloidal silica mixed after this, and said hollowed part 3 was removed. Next, the inorganic glass 1 from which the hollowed part 3 was removed was immersed in concentration 0.025vol% of fluoric acid solution, and was etched, it was immersed in the alkaline etching reagent of pH12 after that, the deterioration layer 7 was removed, and the specimen of Example 7 was produced.

[0092]And when the shape of surface type of this specimen was observed by AFM (atomic force microscope), on the surface of the specimen, the 50 minute heights 5 per 10-micrometer$^2$ were formed, the shape was the Yamagata shape of the approximate circle form where the bottom was 4 micrometers in diameter, and projected height was 100nm**10nm.

[0093][Example 8] alumina abrasive soap with a particle diameter of 5 micrometers -- 17vol% -- a nozzle at 25 mm/sec in speed, blowing off the included slurry from a 90x2.0-mm nozzle to misty state with the compressed air of 0.05MPa. The inorganic glass 1 surface of the presentation 1 was scanned and sprayed, and the compression layer 4 of a large number which have the hollowed part 3 by this was formed. 60 nm was ground using the slurry which mixed cerium powder after that, and said hollowed part 3 was removed. Next, the inorganic glass 1 from which the hollowed part 3 was removed was immersed in concentration 0.10vol% of fluoric acid solution, and was etched, it was immersed in the alkaline etching reagent of pH12 after that, the deterioration layer 7 was removed, and the specimen of Example 8 was produced.

[0094]And when the shape of surface type of this specimen is observed by AFM, on the surface of a specimen, the 84 minute heights 5 per 10-micrometer$^2$ are formed, and the shape is the Yamagata shape of an approximate circle form where the bottom is 570 nm in diameter. Projected height was 130**5 nm.

In this method, since the compression layer 4 was made to form with wet blasting, height was able to form the well equal projection, without generating a crack.

[0095][Example 9] The inorganic glass 1 of the presentation 1 was used, the probe for product SPM made from a diamond coat silicon single crystal which is the spherical surface shape whose curvature radius at a tip is 10 nm in load-rate 46 N/m was pressed against the inorganic glass 1 surface, and was swept to linear shape, and the compression layer 9 which has a hollowed part by this was formed. Next, this inorganic glass 1 was immersed in concentration 0.10vol% of fluoric acid solution, and was etched, it was immersed in the alkaline etching

reagent of pH12 after that, the deterioration layer 11 was removed, and the specimen of Example 9 was produced.

[0096]And when the shape of surface type of this specimen was observed by AFM, it turned out that the projection of the shape of a ridge 1 micrometer in width and 100**5 nm in height is formed with sufficient accuracy along the marks which swept the probe on the surface of a specimen.

[0097][Example 10] The processing same on the inorganic glass 1 surface of the presentation 5 as Example 8 was performed, and the specimen of Example 10 was produced.

[0098]And when the shape of surface type of this specimen was observed by AFM, on the surface of the specimen, the 49 minute heights 5 per 10-micrometer$^2$ were formed, and the shape was the Yamagata shape of the approximate circle form where the bottom was 460 nm in diameter. The projected height is 120**5 nm, and the uniform minute heights 5 with small dispersion in projected height were formed. Thus, the minute heights 5 were able to be formed in the surface also in the inorganic glass 1 of the presentation containing $B_2O_3$ other than aluminum$_2O_3$.

[0099][Example 11] The processing same on the inorganic glass 1 surface of the presentation 6 as Example 8 was performed, and the specimen of Example 11 was produced.

[0100]And when the shape of surface type of this specimen was observed by AFM, on the surface of the specimen, the 11 minute heights 5 per 10-micrometer$^2$ were formed, and the shape was the Yamagata shape of the approximate circle form where the bottom was 330 nm in diameter. The projected height is 100**5 nm, and the uniform minute heights 5 with small dispersion in projected height were formed. Thus, also in the inorganic glass 1 of the presentation containing $B_2O_3$ other than aluminum$_2O_3$, the minute heights 5 were able to be formed in the surface like Example 10.

[0101][Example 12] The processing same on the inorganic glass 1 surface of the presentation 7 as Example 4 was performed, and the compression layer 4 which has the hollowed part 3 was formed. Next, the inorganic glass 1 from which the hollowed part 3 was removed was immersed in concentration 0.10vol% of fluoric acid solution, and was etched, it was immersed in the alkaline etching reagent of pH12 after that, the deterioration layer 7 was removed, and the specimen of Example 12 was produced.

[0102]And when the shape of surface type of this specimen was observed by AFM, the minute heights 5 were formed on the surface of the specimen, and the shape had the shape of a caldera used as the approximate circle form whose bottom is 5 micrometers. The projected height of the somma portion was 0.8 micrometer.

[0103][Example 13] The processing same on the inorganic glass 1 surface of the presentation 8 as Example 4 was performed, and the compression layer 4 which has the hollowed part 3

was formed. Next, the inorganic glass 1 from which the hollowed part 3 was removed was immersed in concentration 0.10vol% of fluoric acid solution, and was etched, it was immersed in the alkaline etching reagent of pH12 after that, the deterioration layer 7 was removed, and the specimen of Example 13 was produced.

[0104]And when the shape of surface type of this specimen was observed by AFM, the minute heights 5 were formed on the surface of the specimen, and the shape had the shape of a caldera used as the approximate circle form whose bottom is 10 micrometers. The projected height of the somma portion was 1.3 micrometers.

[0105][Comparative example 1] After grinding in order to use the inorganic glass 1 of the presentation 4 and to raise the smooth nature of the surface of this inorganic glass 1, Potassium nitrate and sodium nitrate immerse this inorganic glass 1 in the fused salt prepared by 6:4 by the capacity factor under the temperature of 380 ** for 1 hour, perform chemical strengthening treatment, form the compression layer 4, and it ranks second, The inorganic glass 1 was irradiated with the wavelength of 266 nm, the output of 10 mW, and the laser beam of 5 ns of pulse width, and the specimen of the comparative example 1 was produced.

[0106]And when the shape of surface type of this specimen was observed by AFM (atomic force microscope), the surface of the specimen upheaved, much minute heights 5 were formed, the shape was the Yamagata shape of the approximate circle form where the bottom was 5 micrometers in diameter, and projected height was 30nm**15nm. That is, the projected height of the minute heights 5 is 30nm**15nm, and the comparative example 1 was understood that the variation degree is large compared with Example 1 and Example 7.

[0107][Comparative example 2] After grinding in order to use the inorganic glass 1 of the presentation 1 and to raise the smooth nature of the surface of this inorganic glass 1, it held at the temperature of 460 ** for 2 hours, and distortion by polish was removed. Subsequently, the indenter 2 which consists of a diamond formed in the surface of the inorganic glass 1 at the pyramid shape of 136 degrees of vertical angles was pressed for 15 seconds by 500 g (4.2GPa) of load, and the compression layer 4 which has the hollowed part 3 by this was formed. And 500 nm was ground using the slurry which colloidal silica mixed after this, and said hollowed part 3 was removed. Next, the inorganic glass 1 from which the hollowed part 3 was removed was immersed in concentration 0.15vol% of fluoric acid solution, and was etched, it was immersed in the alkaline etching reagent of pH12 after that, the deterioration layer 7 was removed, and the specimen of the comparative example 2 was produced.

[0108]And when the shape of surface type of this specimen is observed by AFM (atomic force microscope), they are formed by the minute heights 5 on the surface of a specimen, and the shape, The bottom was the caldera shape of the one-side approximately square which is 40 micrometers, the projected height of a somma part has a flat field in the crowning at 700 nm, and the crack generated it around the minute heights 5.

[0109]That is, in the comparative example 2, since load of the big load of 4.2GPa was carried out to inorganic glass and the compression layer 4 was formed, the crack occurred around the minute heights 5.

[0110]

[Effect of the Invention]According to the processing method of the amorphous materials applied to this invention as explained in full detail above, the compression layer by which densification was carried out by carrying out load of the predetermined welding pressure selectively to the surface of amorphous materials is formed, Subsequently, since the surface layer of said amorphous materials was removed using the processing agent from which removal ability differs in this compression layer and incompressible layers other than this compression layer and said compression layer is processed into the convex configuration, minute heights with uniform projected height can be formed by arbitrary patterns.

[0111]The etching process of an incompressible layer can be efficiently promoted by using the acidic solution containing acid, especially the acidic etchant containing fluoric acid as said etching reagent.

[0112]Since an alkaline etching reagent performs the 2nd etching process after performing the 1st etching process by said acidic etchant, the deterioration layer formed in the surface of an incompressible layer after the 1st etching process is removed by the alkaline solution, and a glass surface can be made into the inside of glass, and the same quality.

[0113]When said amorphous materials contain a silicon oxide and an aluminum oxide at least, In the compression layer by which densification was carried out, the elaborated silicon oxide bars elution of other ingredients, on the other hand, acid-proof low aluminum is preferentially etched in an incompressible layer, and, as a result, desired minute heights can be formed promptly and easily.

[0114]Since an alkali earth metal oxide is easily eluted to the alkaline solution containing a chelating agent, Amorphous materials contain at least a silicon oxide and at least one or more sorts of oxides chosen from the alkali earth metal oxide, And when the alkaline etching reagent containing a chelating agent is used, it also enables the etching operation of only an alkaline etching reagent to promote etching with an alkaline etching reagent, therefore to form fine irregularities on the surface of amorphous materials.

[0115]The desired compression layer 9 can be easily obtained in arbitrary positions pressing and forming the indenter 8 which has bigger hardness than the hardness of said amorphous materials for the compression layer 9, or by making it move, where said indenter 8 is pressed on the surface of amorphous materials, and forming said compression layer 9.

[0116]Detailed processing can be performed by making said indenter 8 into a probe.

[0117]Certainly detailed processing can be performed by making said probe into probes, such as scanning probe microscopy, especially.

[0118]Many compression layers 4 can be obtained at once by making the particles which have bigger hardness than the hardness of amorphous materials for said compression layer 4 collide with the surface of said amorphous materials, and forming them.
[0119]The surface damage of amorphous materials is avoidable by making said particle into slurry.
[0120]After forming said compression layer, a surface treatment is performed to this compression layer.
Then, minute heights can be formed, without the hollowed part formed of the indenter by removing a surface layer using a processing agent remaining.

[0121]Said surface treatment can remove easily the hollowed part formed by press of the indenter by grinding with the loose grain which has the hardness of said amorphous materials, and the hardness below equivalent, for example, colloidal silica.
[0122]And amorphous materials comprise the multicomponent system inorganic glass 1, and the glass substrate concerning this invention. By forming heights by the above-mentioned processing method, this glass substrate is used for the substrate for magnetic disks, A magnetic head can be effectively prevented from adhering to a substrate at the time of starting, even when it drives with CSS, Furthermore the read error by the collision between a magnetic head, a substrate, gap change of a between and a magnetic head, and a substrate can be prevented, and the magnetic disk board excellent in noise figure can be obtained.

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[Translation done.]